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CONNECTICUT RIVER BASIN
SOUTH BARRE, MASSACHUSETTS



POWDER MILL POND DAM
MA 00092

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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SEP 6 1984

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

NOVEMBER 1978

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20. ABSTRACT (Continue on reverse side if necessary and identify by block member)

Poweder Mill Pond Dam consists of an ungated concrete spillway approximately 125 feet long and 20 feet high, a short emergency spillway and an outlet canal with two inoperative timber gates. Powder Mill Pond Dam is currently classified as having a "high" hazard potential. Based on visual inspection, the facility is in fair to poor condition. Based on size and hazard classifications, the test flood for this dam is the PMF.



DEPARTMENT OF THE ARMY

NEW ENGLAND DIVISION. CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO ATTENTION OF: NEDED-E

JUN 1 8 1979

Honorable Edward J. King Governor of the Commonwealth of Massachusetts State House Boston, Massachusetts

Dear Governor King:

I am forwarding for your use a copy of the Fowder Mill Pond Dam Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. The report is based upon a visual inspection, a review of past performance, and a preliminary hydrological analysis. A brief assessment which emphasizes the inadequacy of the project spillway under test flood conditions is included at the beginning of the report.

The preliminary hydrologic analysis has indicated that the spillway capacity for the Powder Mill Pond Dam would likely be exceeded by floods greater than 37 percent of the Probable Maximum Flood (PMF), the test flood for spillway adequacy. Screening criteria for initial review of spillway adequacy specifies that this class of dam, having insufficient spillway capacity to discharge fifty (50) percent of the PMF, should be adjudged as having a seriously inadequate spillway and the dam assessed as unsafe, non-emergency, until more detailed studies prove otherwise or corrective measures are completed.

The classification of "unsafe" applied to a dam because of a seriously inadequate spillway is not meant to indicate the same degree of emergency as would be associated with "unsafe" classification applied for a structural deficiency. It does mean, however, that based on an initial screening and preliminary computations there appears to be a serious deficiency in spillway capacity. This could render the dam unsafe in the event of a severe storm which would likely cause overtopping and possible failure of the dam, significantly increasing the hazard potential for loss of life downstream from the dam.

NEDED-E Honorable Edward J. King

It is recommended that within twelve months from the date of this report the owner of the dam engage the services of a professional or consulting engineer to determine by more sophisticated methods and procedures the magnitude of the spillway deficiency. Based on this determination, appropriate remedial mitigating measures should be designed and completed within 24 months of this date of notification. In the interim a detailed emergency operation plan and warning system should be promptly developed. During periods of unusually heavy preciptiation, round-the-clock surveillance should be provided.

I have approved the report and support the findings and recommendations described in Section 7, with qualifications as noted above. I request that you keep me informed of the actions taken to implement these recommendations since this follow-up is an important part of the non-Federal Dam Inspection Program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. This report has also been furnished to the owner of the project, Barre Wool Combing Company, Vernon Street, South Barre, Massachusetts 01074.

Copies of this report will be made available to the public, upon request to this office, under the Freedom of Information Act, thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for the cooperation extended in carrying out this program.

Sincerely yours,

JOHN P. CHANDLER

Colonel, Corps of Engineers

Division Engineer

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CONNECTICUT RIVER BASIN
SOUTH BARRE, MASSACHUSETTS

POWDER MILL POND DAM

MA 00092

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS 02154

NOVEMBER 1978

PHASE I INVESTIGATION REPORT NATIONAL DAM INSPECTION PROGRAM

Identification No.:

Name of Dam:

Town: County: State:

Stream:

Date of Site Visit:

MA 00092

Powder Mill Pond

South Barre Worcester Massachusetts Ware River 11 May 1978

BRIEF ASSESSMENT

Powder Mill Pond Dam is located on the Ware River approximately one mile upstream of South Barre, Massachusetts. The dam, reconstructed in 1908 to generate electric power for the Barre Wool Combing Company, consists of an ungated concrete spillway approximately 125 ft. long and 20 ft. high, a short emergency spillway and an outlet canal with two inoperative timber gates. The dam was extensively modified during the 1930's.

Powder Mill Pond Dam is currently classified as having a "high" hazard potential in the Corps of Engineers National Inventory of dams.

Based on a visual examination of the structure, the facility is in fair to poor condition. Nevertheless, there was no evidence of structural failure or other conditions which would warrant urgent remedial treatment.

Based on size and hazard classifications in accordance with Corps of Engineers guidelines, the test flood for this dam is the Probable Maximum Flood (PMF). The PMF outflow of 48,160 cfs would overtop the dam by 5.15 ft. With the water level at top of dam, the main and emergency spillways can pass 17,940 cfs which is 37 percent of the test flood.

The Barre Wool Combing Company, owner of the dam, should engage a registered professional engineer to determine the structural stability of the main spillway, to evaluate alternative measures for increasing the discharge capability of the dam and to inspect the spillway weir under no flow condition as outlined in Section 7.2. The results of those investigations and remedial measures, including restoration of the outlet works to operational condition, repair of concrete surfaces

and reconstruction of slope protection as outlined in Section 7.3 should be implemented by the owner within one year after receipt of this report.

CHERLIN OF MASON

HTRL 2 ALDR 04, JR.

HALEY & ALDRICH, INC. by:

President

This Phase I Inspection Report on Powder Mill Pond Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

CHARLES G. TIERSCH, Chairman Chief, Foundation and Materials Branch Engineering Division

FRED J. RAVENS, Jr., Member Chief, Design Branch Engineering Division

SAUL COOPER, Member Chief, Water Control Branch Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR

Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, DC 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I Investigations are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the test flood is based on the estimated "probable maximum flood" for the region (greatest reasonably possible storm run-off), or a fraction thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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1. Overview of downstream face of dam



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PHASE I INVESTIGATION REPORT NATIONAL DAM INSPECTION PROGRAM POWDER MILL POND DAM MA 00092

SECTION 1-PROJECT INFORMATION

1.1 GENERAL

A. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region.

Haley & Aldrich, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed were issued to Haley & Aldrich, Inc. under a letter dated 26 April 1978 from Colonel Ralph T. Garver, Corps of Engineers. Contract No. DACW33-78-C-0301 has been assigned by the Corps of Engineers for this work. Camp, Dresser & McKee, Inc. was retained as consultant to Haley & Aldrich, Inc. on the structural, mechanical/electrical and hydraulic/hyrologic aspects of the investigation.

- B. Purpose. The primary purposes of the National Dam Inspection Program are to:
- l. Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
- 2. Encourage and prepare the states to initiate quickly effective dam safety programs for non-Federal dams.
- 3. To update, verify and complete the National Inventory of Dams.

1.2 PROJECT DESCRIPTION

- A. <u>Location</u>. The Powder Mill Pond Dam is located on the Ware River, approximately one mile upstream (northeast) of South Barre, Massachusetts and the MDC's diversion to the Coldbrook intake as shown on the Location Map, page viii.
- B. Dam and Appurtenances. The main portion of the dam is formed by a main spillway with flashboards and a short emergency spillway separated by a concrete pier. Right of the spillways is a rectangular concrete outlet canal. The right earth abutment is flat and contains a concrete core wall. A plan sketch of the configuration of the dam is shown in Appendix C-1.

The broad earth abutments left of the spillways and right of the outlet canal are shown in Photos No. 2 and 10, respectively. There is an approximately 90 ft. long concrete core wall, the top of which is visible, in the right abutment. The abutments are generally flat and grass-covered. Brush and small trees are growing on the upstream sides.

The concrete ogee spillways are approximately 155 ft. long and 13 ft. high. The main and emergency spillway crest elevations are 624.6 and 628.6, respectively. However, flashboards 2.7 ft. high at the main spillway bring the normal operating levels to about El. 627.3. The spillways are shown in several photos in Appendix C.

An outlet canal with two timber slide gates is located on the right side. Water formerly discharged through the canal to generate power. The outlet canal and gates are shown in Photos No. 8 and 9.

- C. Size Classification. Powder Mill Pond Dam has an estimated maximum storage capacity of 336 acre-feet and the embankment has a maximum height of approximately 21 ft. According to guidelines established by the Corps of Engineers, storage capacity of less than 1000 acre-feet and height of less than 40 ft. classifies Powder Mill Pond Dam in the "small" category.
- D. <u>Hazard Classification</u>. Powder Mill Pond Dam is currently classified as having a "high" potential in the Corps of Engineers National Inventory of Dams. A failure of the embankment would cause an increase in the water surface elevation in South Barre Mill Pond. As shown in the Phase I Investigation report for South Barre Mill Pond Dam, should

this dam fail, excessive damage to industrial, commercial and residential structures as well as loss of life would occur. The dense multi-family housing immediately downstream of the dam would bear the full brunt of a dam failure. Therefore, it is recommended that the current hazard classification of "high" be retained.

E. Ownership. The dam has been owned by the Barre Wool Combing Company since 1902. The owner's address is: Barre Wool Combing Company, Vernon Street, South Barre, MA 01074 (phone: 617/355-2921). The owner was represented by Mr. John Gould during the course of this investigation.

Prior to 1902 the dam was reportedly owned by the heirs of Nathan L. Pratt of Sudbury, MA and George Heywood of Concord, MA.

- F. Operator. Mr. John Gould is assigned responsibility for operation and maintenance of the dam.
- G. <u>Purpose</u>. The dam was reconstructed in 1908 to create a water supply for generating power. Presently the dam serves no specific purpose since the mill has been closed.
- H. Design and Construction History. The details of the original dam constructed prior to 1902 are unknown. In 1908, the dam was reconstructed for the Barre Wool Combing Co. by the R.I. Contract Engineering Co. of Providence, Rhode Island. L.B. Dow of Boston, MA was the consulting engineer.

Construction plans indicate that the main spillway was constructed with a ll6-ft. long weir. Electric power generating equipment was installed at the discharge end of the outlet canal. An approximately 20-ft. long abutment wall extended right of the canal. Correspondence by the City Engineer (See Appendix B-3) indicates that the dam was founded on gravel approximately 6 ft. below the river bed. There was concern about the lack of riprap on the upstream side of the abutments and the quality of backfill under the foundation of the apron. The construction plans were apparently filed well after construction was underway, and the workmanship received little construction inspection.

In 1931 the County Engineer requested that the owner replace the left wall of the outlet canal, remove

and replace other deteriorating concrete in the area, and backfill with gravel between the canal and the right end of the main spillway. This letter is included in Appendix B-6. These repairs were reportedly made in 1933 in accordance with a drawing entitled "Plan of Repairs to Canal Wall Sluiceway and Intake".

Apparently concern about the dam was expressed after the 1936 flood which resulted in a construction drawing entitled "Plan of Proposed Repairs and Changes to Powder Mill Dam", approved 14 August 1936, shown in Appendix B-7. The major changes included lengthening the spillway weir to 125 ft., adding a new 80-ft. long concrete core wall right of the outlet canal, and placing riprap downstream of the spillways.

It is not clear from the available documents exactly when the main spillway weir was increased in length to 125 ft. and if and when the other changes proposed in 1936 were actually made. In any case, an inspection report dated 26 September 1938, Appendix B-11, states the 1938 flood "washed out north (right) abutment and wing completely for 50 ft. Main concrete spillway was not damaged." A sketch of a temporary clay cofferdam built upstream of the washout at the right abutment to divert the river back over the spillway appears in an inspection report dated 6 January 1939, Appendix B-13.

A statement concerning the proposed repairs to the dam following the 1938 flood appears in Appendix B-8. The repairs included rebuilding sections of the outlet structure and adding an approximately 90-ft. long earth embankment with concrete core wall right of the outlet works. This work is shown in a plan approved 21 March 1939 in Appendix B-9. The left abutment was fortified by raising the concrete wall sections and adding backfill. Immediately downstream an approximately 72-ft. long timber cribwork was constructed to protect the left bank. This work is shown in a plan dated 15 July 1939 in Appendix B-10.

No apparent modifications are known to have been made to the dam since 1939. Fill has been placed downstream of the core wall on the right side to make the ground surface level. Prior to the 3 August 1964 inspection, the power house had been removed.

I. Normal Operational Procedures. There is no formal established routine for the operation of the dam. The gates are not operable.

1.3 PERTINENT DATA

The elevation of the spillway crest shown on all the available record drawings since 1931 is E1. 630.5. Although the datum for this elevation is unknown, it appears to be 5.9 ft. below National Geodetic Vertical Datum (NGVD), since the main spillway crest elevation is reported by the U.S. Geological Survey to be 624.6 NGVD versus E1. 630.5. All elevations used herein are based on NGVD.

A. Drainage Area. The drainage area of the Ware River above the dam is approximately 98.5 square miles (63,040 acres) of which 55 sq. mi. is controlled by the Corps of Engineers Barre Falls flood control dam which was constructed in 1958. The pond surface when at El. 627 comprises only about 17.9 acres (0.03 percent) of this total. The watershed's topography is rolling to mountainous. The major tributary streams are the East and West Branches of the Ware River and the Burnshirt River.

B. Discharge at Dam Site.

1.	Outlet Works	Two timber gates (not operable)
2.	Maximum known flood at	
•	dam site	14,250 cfs (1938 flood)
3.	Ungated spillway capacity at top of dam	17 940 as at \$1 625 6
4.	Ungated spillway capacity at test flood pool	17,940 CIS &C EI. 035.0
	elevation	48,160 cfs (the test
	4164467011	flood outflow) pro-
		vided the top of dam
		was raised 12 ft. to
		El. 647.6
5.	Gated spillway capacity	
•	at normal pool elevation	Not Applicable
6.	Gated spillway capacity	
•	at test flood pool	
	elevation	Not Applicable
7.	Total spillway capacity	
	at test flood pool	
	elevation	48,160 cfs (the test
		flood outflow) pro-
		vided the top of dam
		was raised 12 ft. to
		El. 647.6
8.	Total project discharge	
	at test flood pool	
	elevation	48,160 cfs at El. 640.75

c.	Elevation.
	1. Top dam635.6
	2. Test flood pool-design surcharge640.75
	3. Design surcharge - Original
	design
	4. Full flood control poolNot Applicable
	5. Recreation pool624.6
	6. Spillway crest
	(with flashboards)627.3
	(without flashboards)624.6
	7. Upstream portal invert
	diversion tunnelNot Applicable
	8. Streambed at centerline of dam614.6
	9. Maximum tailwaterUnknown
	7. MAXIMUM CATTAGCET
D.	Reservoir.
	1. Length of maximum pooll mi. (Est.)
•	 Length of maximum pooll mi. (Est.) Length of recreation pool0.87 mi. (Est.)
	3. Length of flood control
	poolNot Applicable
	-
E.	Storage (acre-feet).
	1. Top of dam
	2. Test flood pool630
	3. Flood control poolNot Applicable
	4. Recreation pool20
	5. Spillway crest20
F.	Reservoir Surface (acres).
	1. Top of dam
	2. Test flood pool62.4
	3. Flood control poolNot Applicable
	4. Recreation pool6
	5. Spillway crest6
G.	Dam Embankment. Not applicable.
Ħ.	Diversion and Regulating Facilities. Not
п.	Diversion and Regulating Facilities. Not applicable.

I. Main Spillway.

1.	Type	Concrete ogee
	Length of weir	
	Crest elevation	
4.	Gates	None (flashboards are
		2.7 ft. high)
5.	U/S Channel	Unknown
6.	D/S Channel	Approximately one
		percent slope
7.	General	
		is 30.5 ft. long

J. Regulating Outlets. Water was used from the reservoir and discharged downstream through a rectangular canal at the right side of the dam. Control of this water was by two single-stem timber gates 9 ft. wide by 5-1/2 ft. high. They were manually operated utilizing a rack and pinion device and a worm gear. The operators were manufactured by S. Morgan Smith of York, PA. The right hand gate has an operable pressure relief opening within the gate. Invert elevation of the gates is 623.0. The gates are presently inoperable and leaking. (See Photos No. 8 and 9).

Discharge from the canal is through a morning glory opening in the floor at the downstream end and a pipe in the right side wall of the channel. The pipe was blocked when the structure it passed through was demolished and the foundation filled in.

SECTION 2-ENGINEERING DATA

2.1 DESIGN RECORDS

The ten record drawings available show proposed construction, modification and repairs, and therefore are considered design records. No design calculations were located.

2.2 CONSTRUCTION RECORDS

No detailed construction records were located. Mention of construction activity was made in several prior inspection reports and subsequent correspondence. A sketch of a temporary cofferdam constructed during repairs to the dam was made in an inspection report dated 6 January 1939.

2.3 OPERATION RECORDS

No operational records other than general river level readings of a nearby gaging station are available.

2.4 EVALUATION

- A. Availability. A detailed list and the location of all the engineering data mentioned in this section and available for use in this report are included in Appendix B. Selected documents from this listing are also included in Appendix B.
- B. Adequacy. While the available data provide some useful information, certain important details regarding the design assumptions, construction materials and construction methods used are lacking or are incorrect. The lack of indepth engineering data did not allow for a thorough Phase I evaluation. The evaluation of the dam is based primarily on visual examination, past performance and engineering judgement.
- C. <u>Validity</u>. The 1908 record drawings are no longer valid, since many changes and modifications were subsequently made to the dam. However, the configuration of the dam and appurtenances shown in 1938 and 1939 record drawings is in general agreement with visual field observations. Elevations shown on these drawings are based on an unknown datum and should not be considered accurate.

SECTION 3-VISUAL EXAMINATION

3.1 FINDINGS

A. <u>General</u>. The Phase I visual examination of Powder Mill Pond Dam was conducted on 11 May 1978.

In general, the project was found to be in fair condition. A number of deficiencies which require correction were noted.

A visual inspection check list is included in Appendix A and selected photographs of the project are given in Appendix C.

B. Dam. The structure has no discernable earth embankment, either left of the spillways or right of the outlet canal.

A broad abutment of earth fill and waste material occurs on the left side. The top of this fill is at or above the level of the left spillway training wall, Photo No. 2. Some erosion and sloughing has occurred behind and around the downstream end of the left spillway wall, Photos No. 2 and 3.

On the right side, an earth embankment approximately 20 ft. high and 90 ft. long with a 2 horizontal to one vertical upstream slope and a 3:1 downstream slope, was constructed in 1939. Since 1939, the area downstream of the embankment has been filled to a nearly level grade to the end of the canal. Only the top of the concrete core wall and some riprap, shown in Photos 10 and 11, are presently visible. Visible portions are in satisfactory condition.

C. Appurtenant Structures. The spillway weir was not observable due to the flow of water over the crest. The left side wall (abutment) was found to be in excellent to good condition. Only minor shrinkage cracks, spalls, and efflorescence were noted. The timber crib wall located downstream of the left side wall has deteriorated and is collapsing, Photo No. 4. The right abutment concrete is in good condition with deterioration only noted in the contact area of the flowing water and at the downstream end.

The emergency spillway wall located between the right

abutment of the main spillway and the outlet canal is in fair condition. The entire downstream surface exhibits staining, efflorescence and loss of the finished surface, Photo No. 7. There is definite deterioration at the cold joint between a concrete cap placed at a later date than the major portion of the wall, as well as at local spots in the wall, as shown in the photograph. Vegetation is present along the top of the wall. A concrete apron made up of concrete and cobbles is present at the base of the wall. This apron is undermined at the downstream end.

The control structure and canal vary in condition, Photos No. 8 and 9. The upstream end of the gate platform has efflorescence present and the edges of the service platform have deteriorated. Nevertheless, the condition is generally good. The channel walls have been repaired at least once in the past and probably more than once. The left wall and portions of the right wall show evidence of undermining due to deterioration of the concrete. Deterioration has taken place at old cold joints and at the juncture with concrete placed at a later date. The walls are braced by steel beams spaning between the walls, Photos No. 8 and 9. The beams are rusted but are in good condition. Considerable debris is present on the floor of the channel.

The two single-stem timber gates at the inlet to the canal are shown in Photo No. 8 and described in detail in Section 1.3J. These gates are inoperable and leak between the planks and at the edges.

- D. Reservoir Area. The area around Powder Mill Pond is relatively flat and generally wooded with some open areas. There were no conditions observed which could cause a sudden increase in sediment load into the reservoir. There is no possibility of a major landslide into the pond which could result in a wave overtopping the dam.
- E. <u>Downstream Channel</u>. The floor of the downstream channel is made up of cobbles and boulders. A steep slope is present on the left side of the channel due to the collapsed crib wall. The channel is bordered by young trees. However, the channel is generally unobstructed and in excellent to good condition.

3.2 EVALUATION

Based on visual observations during the site visit

on 11 May 1978, the general condition of the project is fair. Deficiencies which have been noted require attention and may affect the future performance and safety of the dam.

SECTION 4-OPERATIONAL PROCEDURES

4.1 PROCEDURES

In general, there are no formal procedures to assure regular maintenance and satisfactory operation of the dam.

4.2 MAINTENANCE OF DAM

There are no established procedures or manuals to assure periodic inspection and maintenance of the dam.

4.3 MAINTENANCE OF OPERATING FACILITIES

There is no plan to operate and maintain the timber gates, which are presently inoperable.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

There is no warning system or emergency preparedness plan in effect for this structure.

4.5 EVALUATION

Since failure of the dam would probably cause loss of life and extensive property damage downstream, an annual inspection and maintenance program should be developed. In addition, the Owner should prepare a formal emergency preparedness plan and warning system.

SECTION 5-HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

A. Design Data. Various plans prepared for the Worcester County Engineering Department and dated from 1908 to 1939 were the basis for the construction of the dam and ensuing repairs performed during these years. However, elevations shown on the plan are not considered accurate. Consequently, field measurements of the structure made during the inspection were the basis for the calculations in Appendix D. No hydraulic or hydrologic design data were found for this dam.

The recommended test flood for the size (small) and hazard potential classification (high) of this dam is in the range of one-half probable maximum flood (1/2 PMF) to the probable maximum flood (PMF).

- Experience Data. The PMF was determined by using the peak inflow rate of 1109 cfs per sq.mi. as determined by the New England Division, Corps of Engineers for the Barre Falls Dam which is also on the Ware River, upstream of Powder Mill Pond Dam. The PMF was determined on the basis of the 43.5 sq.mi. drainage area downstream of the Barre Falls Dam. The upstream drainage area was excluded, as the downstream drainage area will have passed its peak before the peak outflow from the Barre Falls Dam reaches this dam. Furthermore, it was assumed that the releases from the Barre Falls Dam would be diverted into the Quabbin Aqueduct at the Coldbrook intake. On the basis of these assumptions, the PMF was calculated to be 48,240 cfs. By taking advantage of surcharge storage, the PMF was decreased to 48,160 cfs. This inflow results in a pond water surface elevation of 640.75 ft. NGVD, which is approximately 5.15 ft. above the top of the dam and 16.15 ft. above the main spillway crest.
- C. <u>Visual Observations</u>. As stated previously, field measurements of the structure were made during the visual inspection. The channel immediately downstream of the dam is approximately 100 ft. wide and covered with cobbles and small boulders. Downstream to Barre Depot Road, the channel narrows down to approximately 60 ft. and has an estimated slope of 1 percent. The embankments under the bridge are

lined with large boulders, and on the day of the inspection the water was about 2 ft. deep at this location. Downstream of Barre Depot Road the channel slope is estimated to be 0.5 percent and has similar characteristics to the upstream channel. The river eventually flows into the South Barre Mill Pond.

- D. Overtopping Potential. As stated previously, the test flood for the size (small) and hazard potential (high) classifications is in the range of 1/2 PMF to PMF. However, because of the large economic losses that would be incurred by a dam failure and the potential loss of life, the test flood is designated to be the probable maximum flood (PMF). Assuming that the flashboards are removed, the total capacity of both spillways is 17,940 cfs at El. 635.6 (top of dam). Since the value of the PMF is approximately 48,160 cfs, the spillways can only pass 37 percent of the test flood. The test flood would overtop the dam by an estimated 5.15 ft.
- E. Evaluation. The spillway is not capable of passing either the PMF or the 1/2 PMF. If a failure of the dam were to occur, it appears that no homes immediately adjacent to the dam would be in danger. However, the waters would be near the top of Barre Depot Road, and there is a strong possibility that the bridge will wash out since much lesser flows in the March 1936 flood caused an abutment washout.

Assuming that the pool level at South Barre Mill Pond Dam would be normal (El. 608.5) at the time, a failure of Powder Mill Pond Dam would cause the dam to be overtopped by approximately 2 ft. This would result in excessive damage to industrial, commercial and residential structures as well as loss of life. An overtopping of 2 ft. would also increase the probability that the South Barre Mill Pond Dam would itself fail.

SECTION 6-STRUCTURAL STABILITY

6.1 EVALUATION OF EMBANKMENT STRUCTURAL STABILITY

There are no discernable earth embankments at the Powder Mill Pond Dam. Both abutments have been created by earth and miscellaneous fill materials. There was no visual evidence of instability or seepage conditions which would pose a hazard to the safety of the dam.

6.2 EVALUATION OF SPILLWAY STRUCTURAL STABILITY

- A. <u>Visual Observations</u>. There was no visual evidence that movement or distress in the spillway concrete has taken place. However, the spillway was obscured by water flowing over the weir. The emergency spillway wall located north of the main spillway does exhibit deterioration but no evidence of movement was noted.
- B. Design and Construction Data. Design data in the form of sketch plans dated 14 August 1936 are available. A review of the plans indicated that they do not show sufficient detail of the spillway currently in place, but do indicate the general conditions of the outlet works and side walls. However, as noted above, they are sketch plans and do not show the details necessary to make an analysis of the stability of the spillway.
- C. Operational Records. No operating records other than prior inspection reports appended to this report are known to exist for the spillway.
- D. Post-Construction Changes. The dam originally constructed in 1908, is known to have undergone a number of substantial changes. Repairs and strengthening of the outlet works are shown on sketch plans dated 1932, 1934 and 1939. Changes to the abutments are shown on a sketch plan dated 14 August 1936, while the timber crib wall is shown on a plan dated 15 July 1939. It is known that the spillway is considerably different than that shown on the 1908 plans. At some time after 1908, a concrete ogee weir was apparently constructed in front of the original spillway.
- E. Seismic Stability. The Powder Mill Pond Dam is located in Seismic Zone 2 and in accordance with

recommended Phase I guidelines does not warrant seismic analysis.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 DAM ASSESSMENT

A. <u>Condition</u>. The visual examination of Powder Mill Pond dam revealed that the structure was in fair condition. Although there were no obvious signs of structural failure or other conditions which would warrant urgent remedial action, several deficiencies were noted.

Based on the results of computations included in Appendix D and described in Section 5, the main and emergency spillways are not capable of passing the test flood, which for this structure is the PMF. The PMF outflow of 48,160 cfs would overtop the dam by 5.15 ft. With the water level at the top of dam, the spillway system can pass 17,940 cfs which is 37 percent of the test flood. Failure of the dam would cause additional loading on the South Barre Mill Pond dam located about one mile downstream.

- B. Adequacy of Information. A review of design and construction data is a highly desirable factor in developing a thorough Phase I assessment. However, there were insufficient engineering data available for this dam to allow for such a review. The evaluation of the dam is based primarily on visual inspection, past performance and engineering judgement.
- C. <u>Urgency</u>. The recommendations for additional investigations and remedial measures outlined in Section 7.2 and 7.3, respectively, should be undertaken by the Owner and completed within one year after receipt of this report.
- D. Need for Additional Investigations. Additional investigations should be performed by the Owner as outlined in the following section.

7.2 RECOMMENDATIONS

It is recommended that the Owner engage a registered professional engineer to undertake the following investigations:

- Perform measurements and analyses to determine the structural stability of the main spillway.
- 2. Perform hydrologic studies to determine what alternative measures are required to increase the discharge capability at the dam. These

alternatives include the repair and modification of the outlet works for the dam and a predetermined operational procedure for the dam.

 Inspect the spillway weir during no flow condition.

7.3 REMEDIAL MEASURES

- A. Operation and Maintenance Procedures. The following remedial work should be undertaken by the Owner:
 - 1. Repair the control gates to restore them to operational condition.
 - Repair the concrete surfaces of the outlet works, the wall between the outlet works and the spillway, and the downstream end of the right abutment to prevent continued deterioration of these structures. Loose, weak concrete should be removed and the surfaces restored by application of concrete mortar, shotcrete, or by other methods.
 - 3. Remove deteriorating crib wall downstream of the left abutment and construct new work to protect the fill materials from erosion. Consideration should be given to the use of heavy stone riprap.

Due to the "high" hazard potential classification, the Owner should establish a formal operations and maintenance manual for this dam. The operating procedure should include provisions for biennial technical inspection of the dam and for surveillance of the dam during periods of heavy precipitation and high river elevations. The procedures should delineate the maintenance work to be done on the dam to ensure satisfactory operation and to minimize deterioration of the facility.

The Owner should also develop a written emergency preparedness plan and warning system to be used in the event of impending failure of the dam. The system should be developed in cooperation with local officials and downstream inhabitants.

7.4 ALTERNATIVES

The Owner should consider the alternatives of taking the dam out of service or filling and sealing the outlet canal. Removing the flashboards, opening the control gates and providing adequate openings at the downstream end of the outlet canal would decrease the hydrostatic loads on the dam and reduce required maintenance. Conversely, the filling of the outlet canal and sealing it would reduce the required maintenance of the structure.

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VISUAL INSPECTION PARTY ORGANIZATION

NATIONAL DAM INSPECTION PROGRAM

Dam: Powder Mill Pond

Date: 11 May 1978

Time: 0805-1505

Weather: Clear and Warm (70's F)

Water Surface Elevation Upstream: Approximately El. 627.8

NGVD

Stream Flow: 125 MGD on 11 May 1978

(M.D.C. Records)

Inspection Party:

Harl P. Aldrich, Jr. Haley & Aldrich, Inc.

Roger H. Wood

Camp, Dresser & McKee, Inc.

Present During Inspection:

John Gould, Barre Wood Combing Co.

VISUAL INSPECTION CHECK LIST NATIONAL DAM INSPECTION PROGRAM

DAM: Powder Mill Pond DATE: 11 May 78

AREA EVALUATED	CONDITION
DAM EMBANKMENT	
Crest Elevation at Earth Abutments Current Pool Elevation Maximum Impoundment to Date	Approximately E1. 634 (NGVD) at left abutment and E1. 635 at right abutment Approximately 627.8 Not known
OUTLET WORKS - INTAKE STRUCTURE	
a. Approach Channel	None - outlet works borders reservoi
Bottom Conditions Log Boom	Not visible None
b. <u>Intake</u>	
Condition of Concrete	Service platform has deteriorated at edges
c. Downstream Canal	
Condition of Concrete Obstructions	Good to fair. Vertical walls have been repaired in past which resulted in good condition of some areas and fair condition in other areas. Considerable efflorescence present. Base of wall undermined left side and local areas right side. Walls braced by steel beam struts at approximately 2/3 of height Considerable debris on floor and in
d. Mechanical and Electrical	outlet No electrical
Gates	Two 9 ft. by 5.5 ft. timber gates - leaks between planks and at edges (see Photo No. 9)
	A-2

D

VISUAL INSPECTION CHECK LIST NATIONAL DAM INSPECTION PROGRAM

DAM: Powder Mill Pond DATE: 11 May 78

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR AND DISCHARGE CHANNELS	
a. Approach Channel	·
General Condition	No channel present - spillway is at edge of reservoir
b. Weir and Training Walls	
General Condition of Concrete	Weir not visible due to flow of water. Left wall good to excellent Timber crib wall downstream left side has collapsed. Right abutment - good to fair. Emergency spillway wall between right abutment and control structure - fair.
Rust or Staining	Appreciable rust and staining down- stream face of emergency spillway.
Spalling	Minor spalls at shrinkage cracks left wall. Erosion at water con- tact area right abutment. Down- stream end of right abutment has deteriorated
Any Visible Reinforcing Any Seepage or Efflo- rescence	None observed Slight efflorescence at cracks on left side and at spots on right side. Considerable efflorescence on face of emergency spillway
Drain Holes Obstructions	None observed Logs, brush and dead animal at weir, lodged in flashboards.
c. Discharge Channel	
General Condition	Good, channel is the natural bed of the river
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	Banks of river are wooded by young trees
Floor of Channel Other Obstructions	Cobbles, boulders (bed of river) None observed

LIST OF AVAILABLE BOCKSHIPS AND PRICE INSUSCICE ESPONS

				Page No.
LIST OF AVA	LLABLE DOCUME	412		1
DOCUMENTS				
Letter fro	om City Engin Nogust 1908	est to Cour	ty Comined	3
Letter fro Company di	m County Eng ated 17 Augus	ineer to be t 1931	ree Mood Co	thing 6
"Plan of I Mill Dam"	Proposed Reps approved 14	irs and Cha Asgust 1936	ngas is for	
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LIST OF AVAILABLE DOCUMENTS POWDER MILL POND DAM

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LOCATION	s for Office of County the Engineer, Court House, Worcester, MA	ents Office of County dam Engineer, Court House, Worcester, MA (Appendix B-3)	and Office of County canal Engineer, Court House, Worcester, MA (Appendix B-6)	new Office of County te Engineer, Court House, d Worcester, MA	Office of County Engineer, Court House, ut- Worcester, MA g (Appendix B-7)
CONTENTS	Four contract drawings for the reconstruction of the dam	Observations and comments on the reconstruction dam	Request for concrete and backfill repairs for can right of dam	Plan showing proposed new canal wall and concrete work for sluiceway and intake	Plans for lengthening spillway to 125 ft., building new right abutment wall, backfilling and riprapping
DOCUMENT	"Plan of Dam and Elevations", L.B. Dow Consulting Engineer, Boston, MA, approved 21 July 1908	Letter from Fredk. A. McClure, City Engineer, to George W. Cook, County Commissioner, Barre, MA, dated 26 August 1908	Letter from Worcester County Engineer to Barre Wool Combing Co., South Barre, MA, dated 17 August 1931	"Plan of Repairs to Canal Wall, Sluiceway and Intake", A.E. Burr Co., approved 10 October 1932	"Plan of Proposed Repairs and Changes to Powder Mill Dam", Hugh Kirkpatrick, P.E., approved 14 August 1936

13.00

MENT	

CONTENTS

LOCATION

Letter from Barre Wool Combing Co. to Lester O. Marden, County Engineer, dated 1 December 1938

ng Description of proposed repairs to dam after washout north of right abutment by 1938 flood

Worcester, MA (Appendix B-8) Office of County

Engineer, Court House,

Worcester, MA

Engineer, Court House,

Office of County

Letter from County Engineer to George H. Delano, Chief Engineer, Mass. Dept. of Public Works, dated 8 December 1938

Request for urgent action after 1938 flood damage to dam

Drawings No. B-14 and B-15 showing new dike and gate constructed north of right abutment after 1938 flood

Sections (Emergency Flood

Control)", Cleverdon,

"Plan of Powder Mill Dam

Varney & Pike, Consulting

approved 21 March 1939

Engineers, Boston, MA

Office of County Engineer, Court House, Worcester, MA (Appendix B-9)

> "Plan of Repair of Canal Wall and Floor", Cleverdon, Varney & Pike, Consulting Engineers, Boston, MA approved 9 May 1939

Repairs made to canal after Of 1938 flood En

Office of County Engineer, Court House, Worcester, MA

> "Plan of Dam Below Powder Mill Dam", Arthur T. Safford Consulting Engineer, 15 July 1939

Plan of timber cribwork and fill constructed on the left bank immediately downstream of dam

Office of County Engineer, Court House, Worcester, MA (Appendix B-10)

Same De Color

City Engineer's Office, Aig. 26, 1968.

Mr. George W. Cook, County Commissioner, Earre, Lass.

Dear Sir:

...

After visiting the dam of the Barre Wool Combing Co. on Aug.15th with you and Mr. C. L. Chamberlain, I wrote Wr. L. S. Dow of Boston, for certain information, a copy of which communication, together with Mr. Dow's reply I enclose.

As you will observe Mr. Tow's reply was an incomplete saster, and on August 21st I wrote him again, copies of which correspondence Talso enclose.

the curtain wall at the westerly end of the dam is being extenced to the bank, and that Mr. Dow himself was not satisfied with the earth dike we observed at that point.

In examining the plans I fail to find any provisions for preventing the water finding its way along the back side of the easterly wing wall of the dam, except the adhesion of the earth to the concrete. The wall has a long, straight, smooth surface, and in my opinion should have buttresses or cut-offs of some description to prevent the infiltration of water at this point, if care was taken with a good clay puddle adjoining the wall perhaps this would back sufficient.

We are still left without very much information as to the

G.N.C. #2.

method of construction employed at the heel of the dam and which Mr. Pow says he criticized, further saying that the contractors used ordinary gravel for the back fill, which would indicate a lack of care and thoroughness of work at this important point. In my opinion a better water excluding material than ordinary gravel, as stated by Mr. Dow, should have been used, and especial pains taken to prevent the water finding its way under the heel of the dam. The fact that a washout occurred with a partial head of water I believe to be very good proof that further trouble of this nature may be expected.

Mr. Now in his letter of August 24th further says that the curtain wall westerly of the gate "Is carried down nearly as low as the toe of the dam" but I am in doubt if this means to include that part of the wall immediately under the gate sills, which ought to be determined with more certainty.

In answer to my inquiry as to the foundation of the apron and how it is secured from undermining, Fr. Tow's letter stated "That the foundation was filled in solid with cobble stones" and that he criticized their method of doing it, he seems to be in doubt of its stability if the dam should spring a leak. The work at this point, as it appeared to me seemed to be hardly deep enough to stand the shock of impact from falling water, in fact I failed to observe from external appearances that any particular provision had been taken to prevent its being undermined. The action of water at all such points has a tendency to create deep excavations, which if it occurs here will threaten the stability of the entire structure in

The state of

Ø.₹.C. 43.

my opinion, as the foundations to the dam at its lower side was stated to us to be very shoul and founded on gravel.

At the easterly and of the dam care should also be taken in the founding of the parties dike and in the material comprising its structure.

It was stated to us on the pround that no rip-rap was contemplated for this surther enhankment.

I do not know the extent of the pond, but should judge from the depth of the water at the com that its area was sufficient to ereate a considerable wave motion, which will soon make serious inroads upon it unless protection is afforded.

could it not be well while the conditions permit of further conservations to satisfy yourself upon the points to which I have called special attention? The fact that the plans were not filed on attention called to this structure until it was pretty well slong in its building makes it rather late in the cay to secure the rank-manship such structures should have.

Personally I should profer to see improvement in other features of its design, but it appears to me that good workmanship at lassistantial be shown in its carrying out, and which I would advise by insisted upon before the structure is subjected to use.

Very truly yours,

August 17,1931.

Barre Wool Combing Company, South Burro, Mass.

. Goutlemon:

An inspection has been recently rade of your concrete dan near the state including to Barre according to the state law and I find that the following repairs should be made:

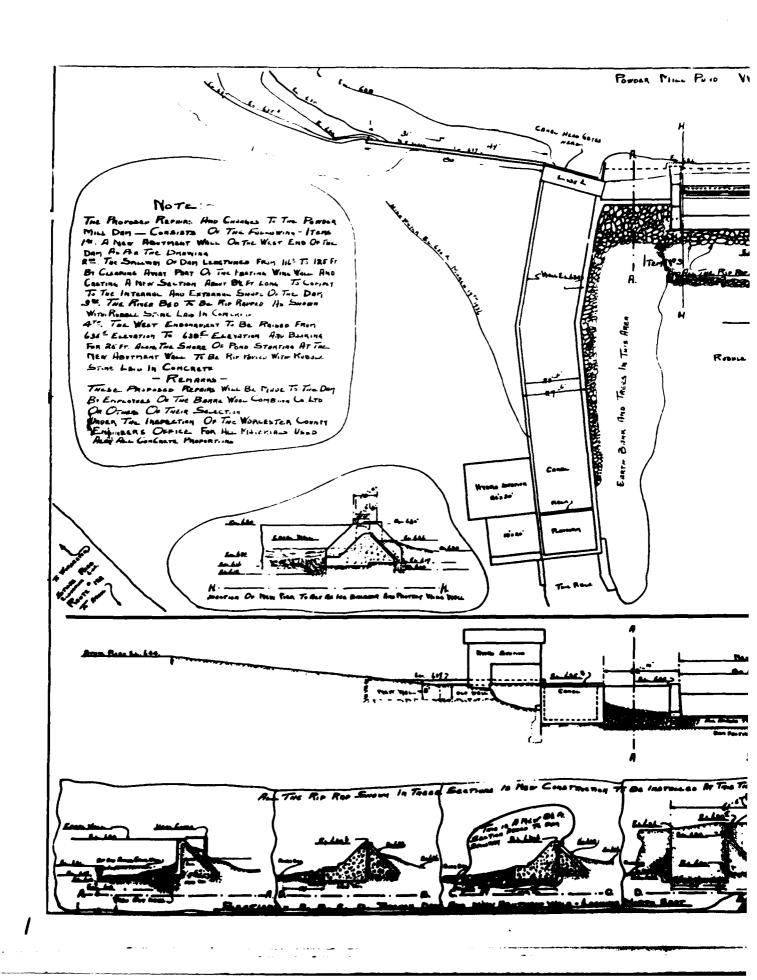
- 1. I notice that the structure appears to be made of very poor concrete and that it is scaling off ground the flume, abutment wall to flume, and to that portion of the dan between the flume and the north abutment to the spilltmy; All old concrete showing disintegration should be out out and now concrete walls properly reenforced should be constructed same.
 - 2. A gravel backfill and concrete slope wall should to constructed minilar to that at the south abutment of the spillway, between the flume and the north spillway abutment.

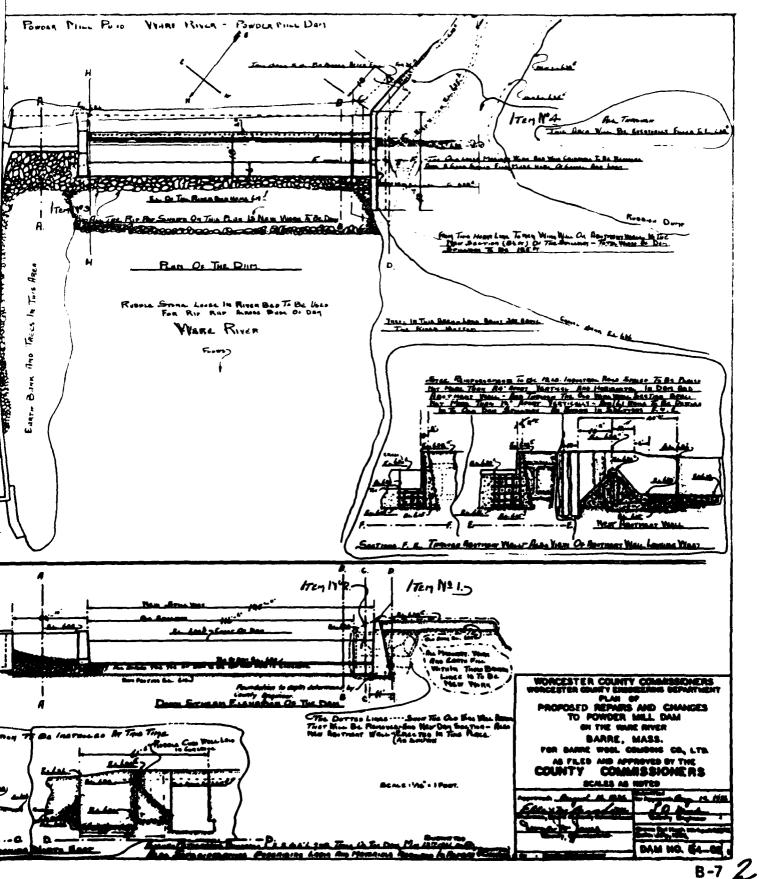
I foul that after meture consideration the changes to your structure are of enough importance to current your submitting a plan to the County Commissioners indicating thereon the lecation and noticed of mixing those discretions.

I feel that the dam is in a weakened condition at the flume and that these alterations should be made.

Yours very truly,

County Ecginoca





THE BARRE WOOL COMBING COMPANY, LTD.

MILLS AT SQUTH BARRE,MASS. COMMISSION WOOL COMBERS

BOSTON PLASS.



December 1, 1958

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Mr. Lester O. Marden, County Engineer Court House Worcester, Massachusetts

Dear Mr. Marden:

Confirming telephone conversation, we understand that the Commissioner of Public Works has authorized certain work in the Ware River at South Barre.

At the Powder Will, the river is to be diverted back into its former course by the construction of a dike from the northeast corner of our forebay, in the northerly direction, toward the State highway.

The river, both above and below the Valley Road Bridge, is to be dredged and as much of the material as possible to be left at the sides of the river as dikes.

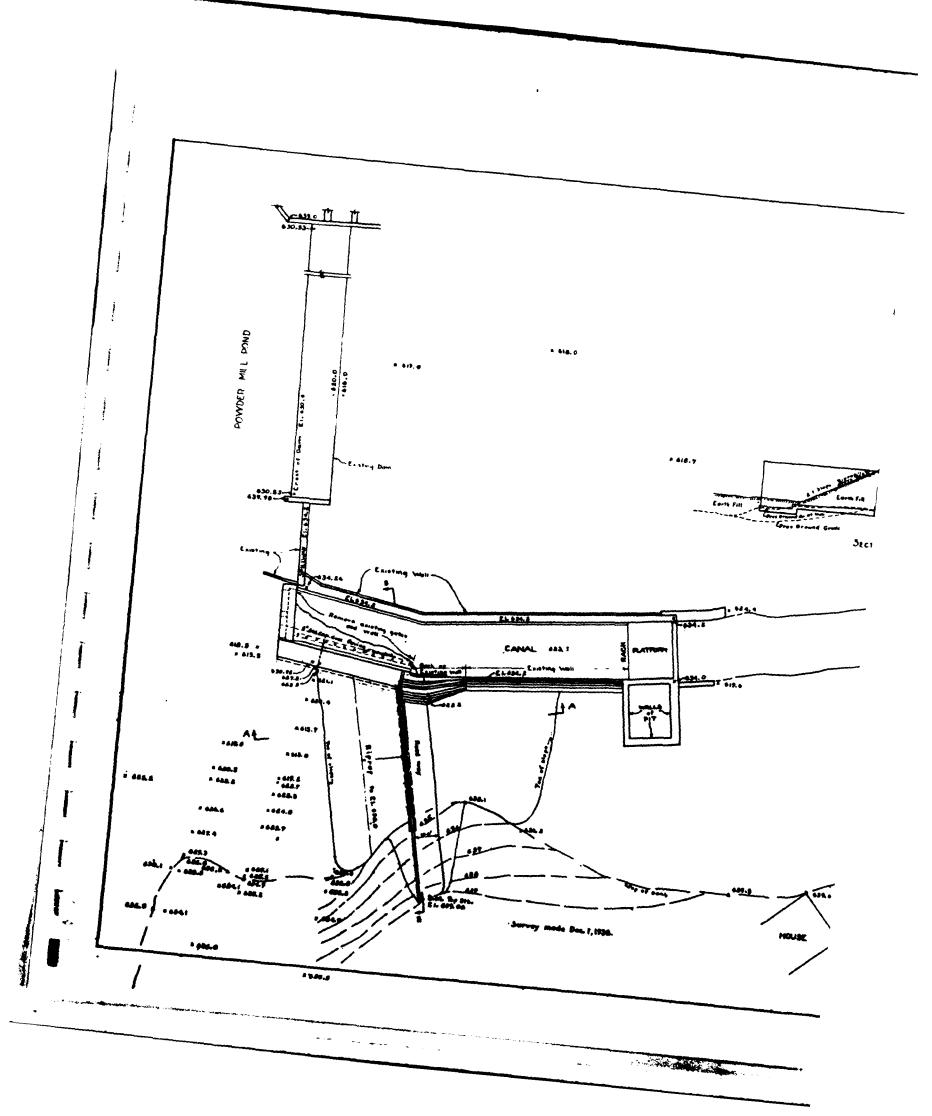
The wing walls below our main dam are to be underpinned and the apron is to be extended further downstream and down into the river bed.

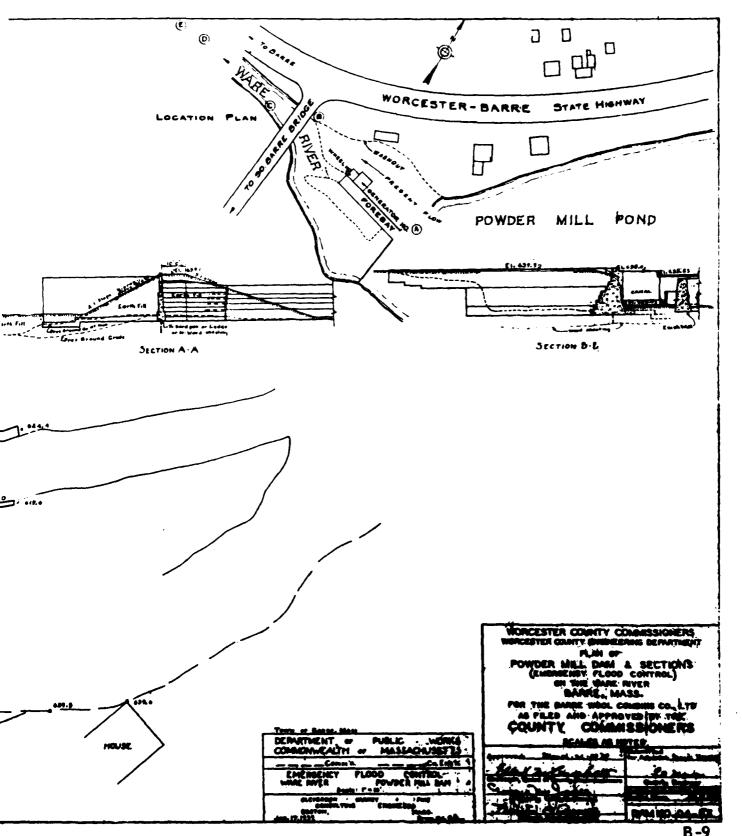
The engineers are at work there at present and we understand that the final drawings will be ready by the end of the week.

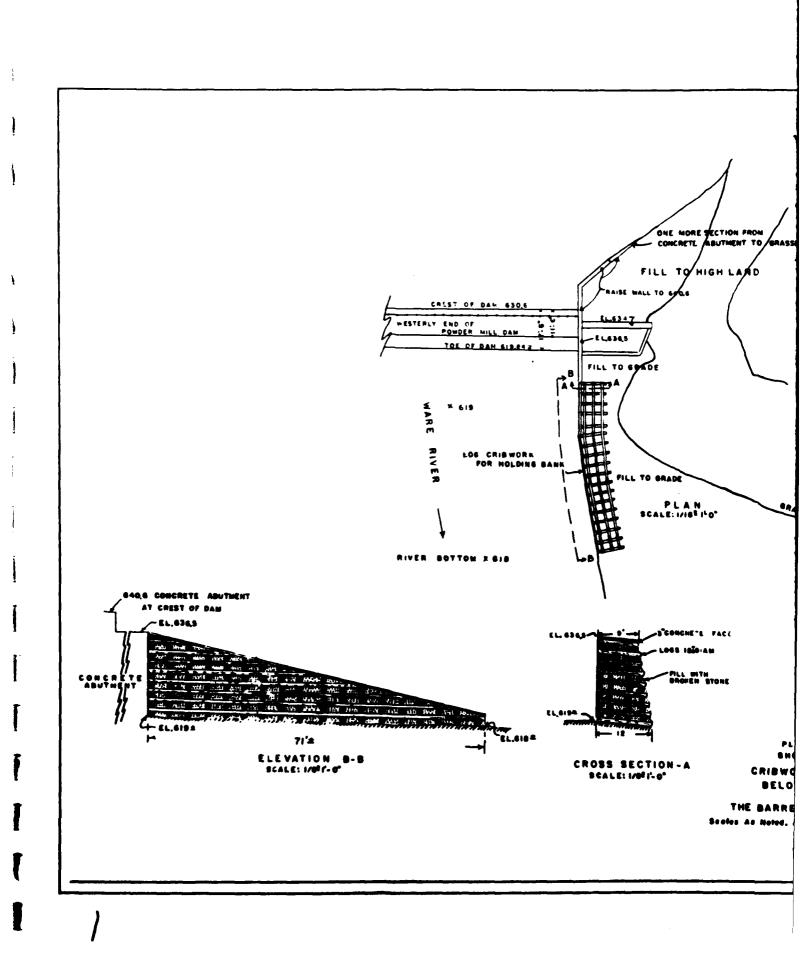
Yery truly yours,

THE BARRE WOOL COMBING COMPANY, LTD.

NO







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PLAN AND SECTIONS SHOWING SUSSESTION OF CRIBWORK FOR WESTERLY BANK BELOW POWDER MILL DAM FOR

THE BARRE WOOL COMBING COMPANY LTD. Scoles As Noted, Arthur T. Sallord, Consulting Engineer, JULY 18,1988. WORCESTER COUNTY COMMISSIONERS
WORCESTER COUNTY ENGINEERING BEPARTMENT
PLAN OF
D A M

BELOW POWDER MILL DAM

FOR THE BARRE WOOL COMBING COMPANY LTD SOUTH, BARRE MASS. COUNTY COMMISSIONERS

SCALES AS MOTED

TRACES SV: EA COL COMMENT DAM HOPDEDS

-COUNTY ENGINEER

B-10

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

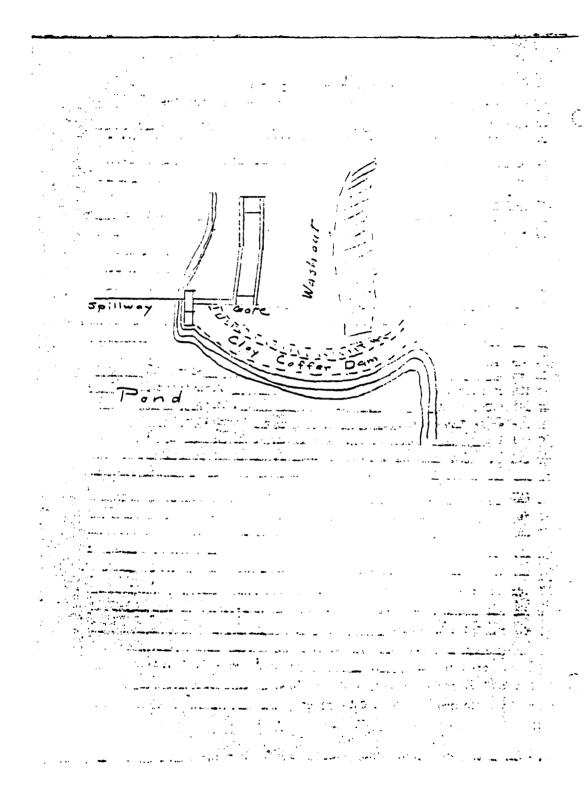
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Owner3	arre Woolen Co.			7 (***********************************
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SPILLWAY-Lei	ngthFeet. Depth	Feet		
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Kind of Foundati	on under Spillway	**************************************	************************	*****************
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	nd Feet per Square Mile		-	
Estimated Staron	Million Cubic Foot			
en and an experience		# CONTRACTOR CON		urarianianianianianianianianianianianianiani

Washed out north abutment and wing completely for 50 ft.
Wain concrete spillway was not damaged. Flood cut around south abutment and washed out a large hole but apparently did not damage abutment. All four gates were closed. Approx. two feet of flashboards were on but were mostly carried away in the flood. Concrete flume at north end seems to be OK. From information given by an observer the water was about five feet over the concrete crest of the spillway or in other words a trifle over the concrete wing at the south end.

04-03

WORCESTER COUNTY ENGINEER

Inspection of Da Inspected by <u>J. 3. 4</u>	· •	•		2. %
inspected by 4-, 10, 97			_Dam NO.	*****
rown Bare	Location			
Owner				
SPILLWAY				
El.top Abutment	El.Crest	El.Apron	El.St.	Beđ
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idth flashboards				
El.Flowline Cleanout Pip	eS1	ze and Kind	Pipe	
Gind of Foundation under	Sgillway			
and of Foundation under Condition <u>Water</u>	1. 3	11.1		
		 		
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umber Acres in Pond	Dr	ninnge Area	in Sq.Miles	
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stimated Storage Million				



WORCESTER COUNTY ENGINEER Inspection of Pams, Reservoir Dams, and Reservoirs Inspected ove MCCrockett-L.O.M Date 4-20-1939 Dam No. 04-03 Town Rarre Location Powder Will Dem-Ware River. Owner Barra Wool Combing Co. Ltd Use Width top Abut. ____ Width top Crest ____ Width bottom Sp.way ____ Width flashboards Kind Flashboards El.Flowline Cleanout Pipe_____Size and Kind Pipe_____ Kind of Foundation under Spillway Condition OK ETBANGIENT EL. Top_____El.Natural Ground______Width Top____ Width of Borrom Upstream Slope Downstream Slope Kind of Corewall Riprap Material in Embankment_____ _____Foundation___ Condition New construction progressing satisfactorily -_____Location____ Kind Ei.Flowline Size___ Condition | Serie Evidence of Leaks in Structure_____ Recent Repairs and Date_____ Number Acres in Pond ______ Drainage Area in Sq. Miles_ Discharge in Second Feet per Square Mile____

Estimated Storago Million Cubic Feet

WORCESTER COUNTY ENGINEER

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Inspection of Par				
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Owner Barra Wool Combing				
SPILLWAY	•			ar ·
El.top abutment	El.Crest	El.Apron	_E1.St.Bed	_
Width top AbutWid				
Width flashboards	Kind F	lashboards		_
El.Flowline Cleanout Pipe	 _	Size and Kind Pi	.pe	_
Kind of Foundation under	Spillway			
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poured in the southeast	erly corner of n	ew extension.		-
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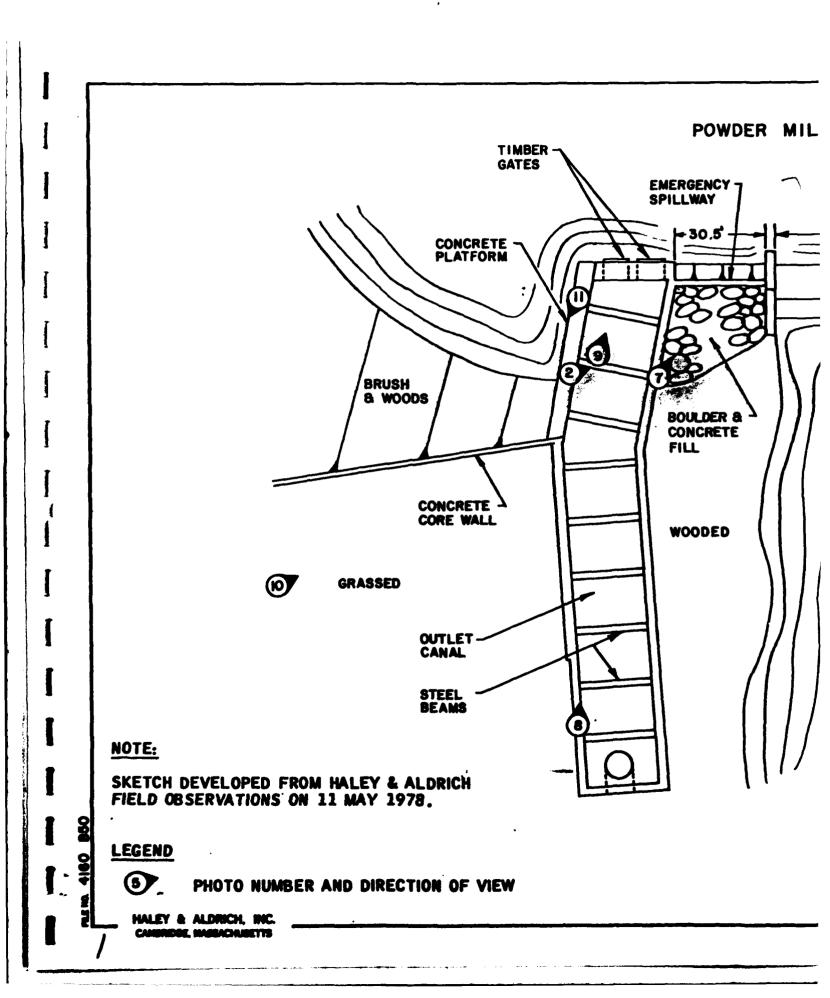
	INSPECTION REPORT & DATA FOR DAMS Owner: Barre Was! Cambing Co His Address: Verner August, Barre Function of Dam: Industrial Location & Access: Intersection of Rolly + New Brainfe Rd USGS Quad. Barre Let. 12:23'40' Long. 72:34'40' Drain.Ar.: 17:25q.Mi.; Ponds: ac.; Res. Gdam: Character of D.A.:	Dam No. 21 - 03 Town: Street Streem: 1/30c Ricco Fond: ConderMill Pass Date: 3 - 1 - 72 By: 1/3/10 Cond CONDITION RATING Structural: For Hydraulic: 1/30 x 25 General: For
	Estimated Discharge: Capacity:	- - -
	General Description of Dam and Discharge Control Concrete dam & Spill way with 2.7 or for more 2-10 galas are probably viaperable	boards in Olan II america
	Sketch (Not to Scale):	······································
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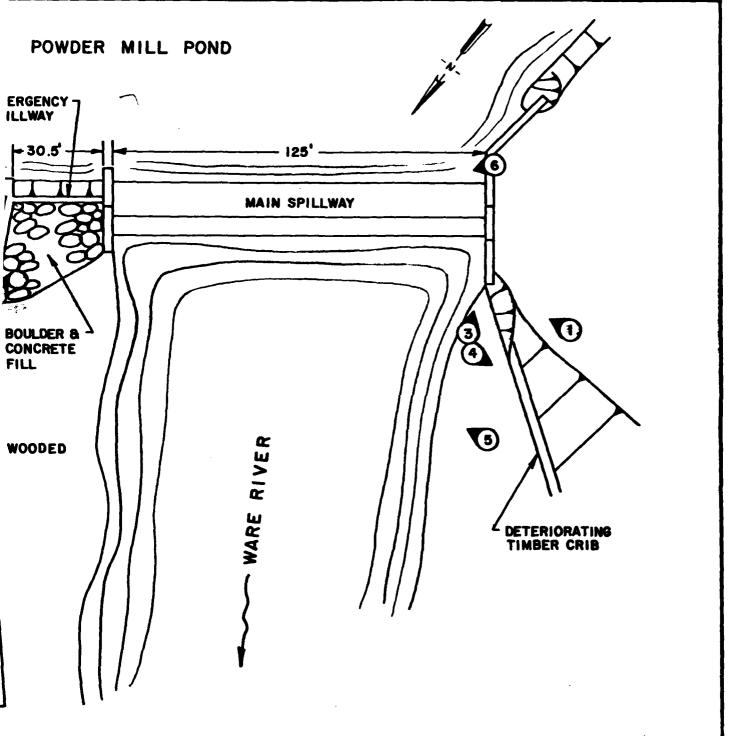
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Powder Mill Pond Dam South Barre, MA

SITE PLAN SKETCH

Apprex. scale: 1"=30' Nov. 1978

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2. Overview of main spillway and left abutment



3. Training wall at left abutment



4. Deteriorating rock crib wall downstream of left abutment



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5. Main spillway showing pier at right end and emergency spillway beyond



6. Overview of right abutment and canal walls

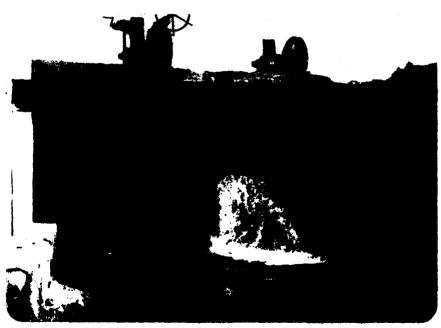


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7. Downstream face of emergency spillway



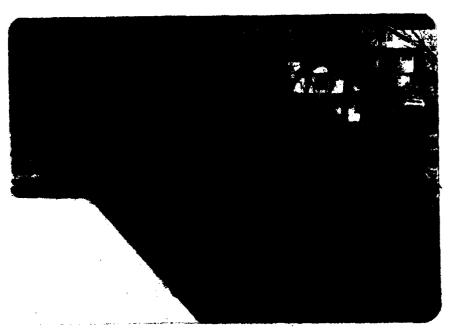
8. Outlet canal, looking upstream



9. Downstream side of outlet works and gates



10. Right abutment showing top of concrete core wall



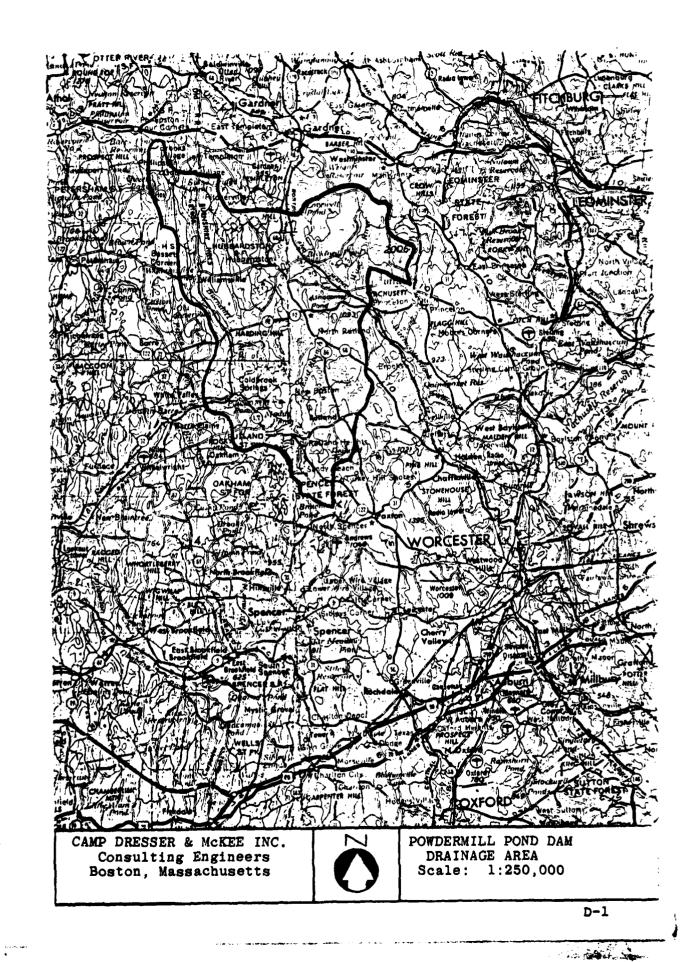
11. Upstream side of right abutment

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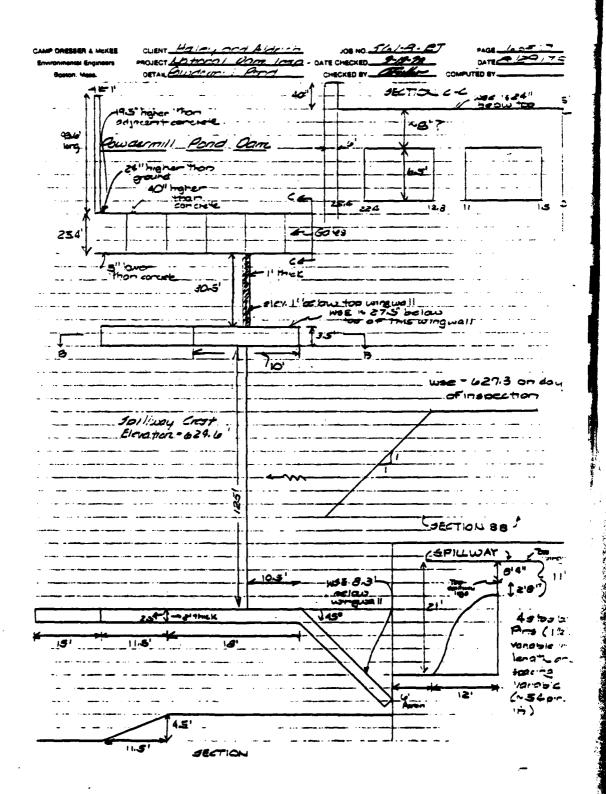


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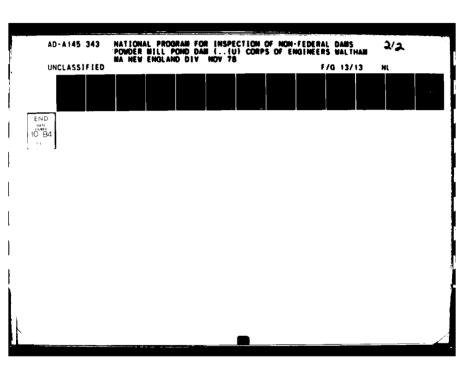
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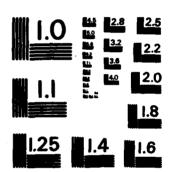
Chief, Water Control Branch

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Chief, Design Branch Chief, F & M Branch Chief, Water Control Branch	Chairman, Dam Safety Review Board T. Fay
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	he report is acceptable in accordance with your ions given to the Architect-Engineer at the
3. If acceptable, retain the (master) approval sheet	he copy for your files and be prepared to sign on 5 42 1979
4. If the report requires as soon as the determination	further work or correction, notify the undersigned n is made.
5. The cost code for this	review 1s ABA0 2 07000000000.
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